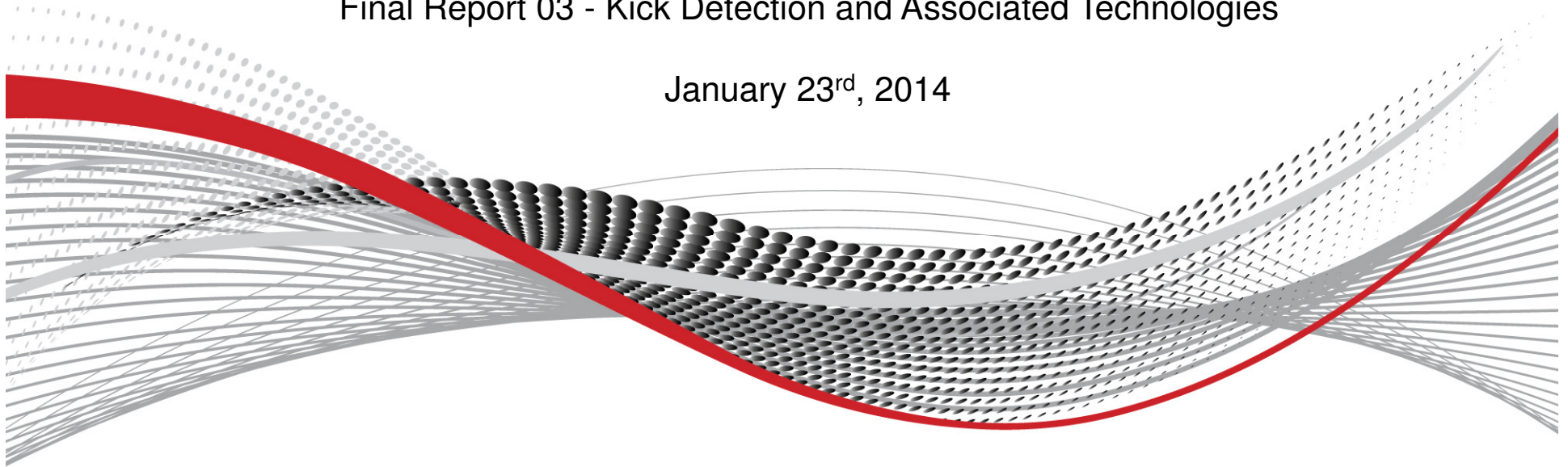




# Assessment of BOP Stack Sequencing, Monitoring and Kick Detection Technology

Final Report 03 - Kick Detection and Associated Technologies

January 23<sup>rd</sup>, 2014



A **WoodGroup** *kenny* business



# Objective



- State of the art kick detection technologies
- Frequency and causes of kicks
- Analysis into kick detection technologies required/available



# Outline



- Objective
- Kick Frequency
- Kick Detection and Management Technologies
- Managed Pressure Drilling
- Human Factor
- Summary

# Kick Frequency



Phase	No. of Kicks	No. of wells	BOP –days in service	MTBK (wells between kicks)	MTBK (BOP –days between each kick)
Development drilling	9	25	1000	2.8	111.1
Exploration drilling	39	58	3009	1.5	77.2
<b>Total</b>	<b>48</b>	<b>83</b>	<b>4009</b>	<b>1.7</b>	<b>83.5</b>

US GoM wells spudded in 1997 and 1998 (Sintef Study)

Phase*	No. of kicks	No. of wells			BOP-days in service	MTBK (wells between kicks)	MTBK (BOP-days between each kick)
		Original	Sidetrack or by-pass	Total			
Development drilling	7	42	11	53	3223	7.57	460
Exploration drilling	74	133	73	206	11833	2.78	160
Total	81	175	84	259	15056	3.20	186

US GoM wells spudded in 2007 and 2009 (Exprosoft Study)

# Kick Incidents



- Low mud weight led to the highest number of kicks (43 kicks out of 81 total kicks)
- Gas cut mud led to the second highest number of kicks (15 kicks out of 81 total kicks)
- Swabbing led to the third highest number of kicks (10 kicks out of 81 total kicks)

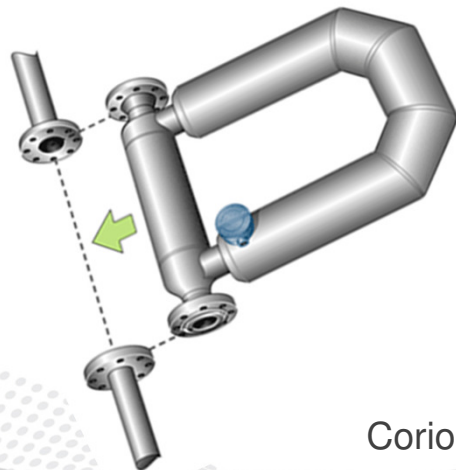
#	Type of Kick	Number of Kicks
1	Mud weight low	43
2	Mud with gas cut	15
3	Swabbing	10
4	Unknown reasons	5
5	Gains and losses in Annular	3
6	Losses in Annular	3
7	Drilling break	2
8	Leaking through cement	2
9	Trapped gas in BOP	1
10	Temperature expansion due to well open for a long time	1

Kick Incidents (Exprosoft study)

# Kick Detection and Management Technologies



- Real time flow data to identify early influx or losses and sound the alarms to notify the personnel on the rig.
- Kick detection systems include flow-in, flow-out, pit volume, surface data, drill pipe pressure, hook load and block position and are displayed on the data displays located in the drillers cabin.
- Coriolis sensors provide a measurement of mass, volume flow rate, density and temperature with minimal loss in accuracy. Used for 15 years mostly in land rigs. Effective only in a closed loop system and low flow rates.



Coriolis Meter





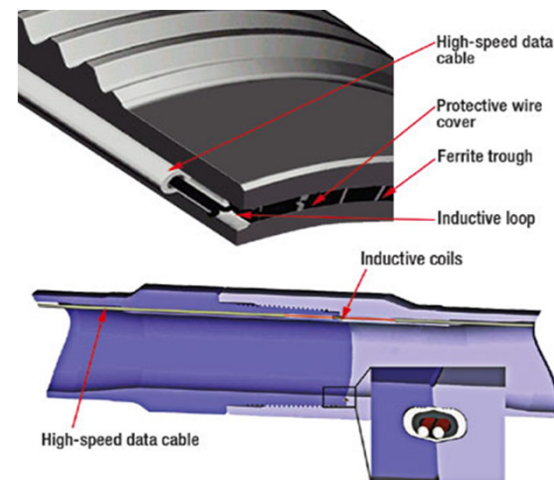
# Kick Detection and Management Technologies



- Measurement While Drilling (MWD) monitors the acoustic properties of the annulus fluid for early gas-influx detection. Pressure pulses generated by the MWD are recorded and compared at the standpipe and the top of the annulus.
- For water-based mud systems MWD has detected gas influxes within minutes before significant expansion occurs.
- Wired drill string systems offer bi-directional communication allowing commands to and from points on the drill string.



Measurement While Drilling Screen



Wired Drill String

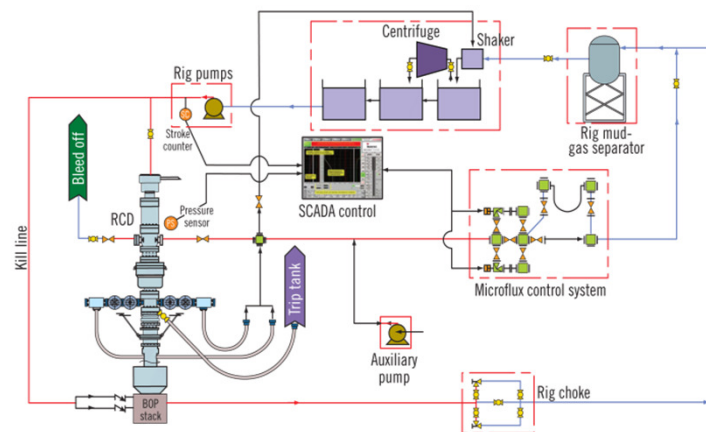
# Managed Pressure Drilling (MPD)



- MPD has been used and perfected for many years for onshore drilling and is now being utilized in offshore drilling.
- Utilizes many different tools and approach to assist in mitigating the risks with drilling.
- Most technologies presently suited for surface BOP.
- Many of the un-drillable wells have become drillable with MPD.

**AUTOMATED CLOSED-LOOP CIRCULATING SYSTEM**

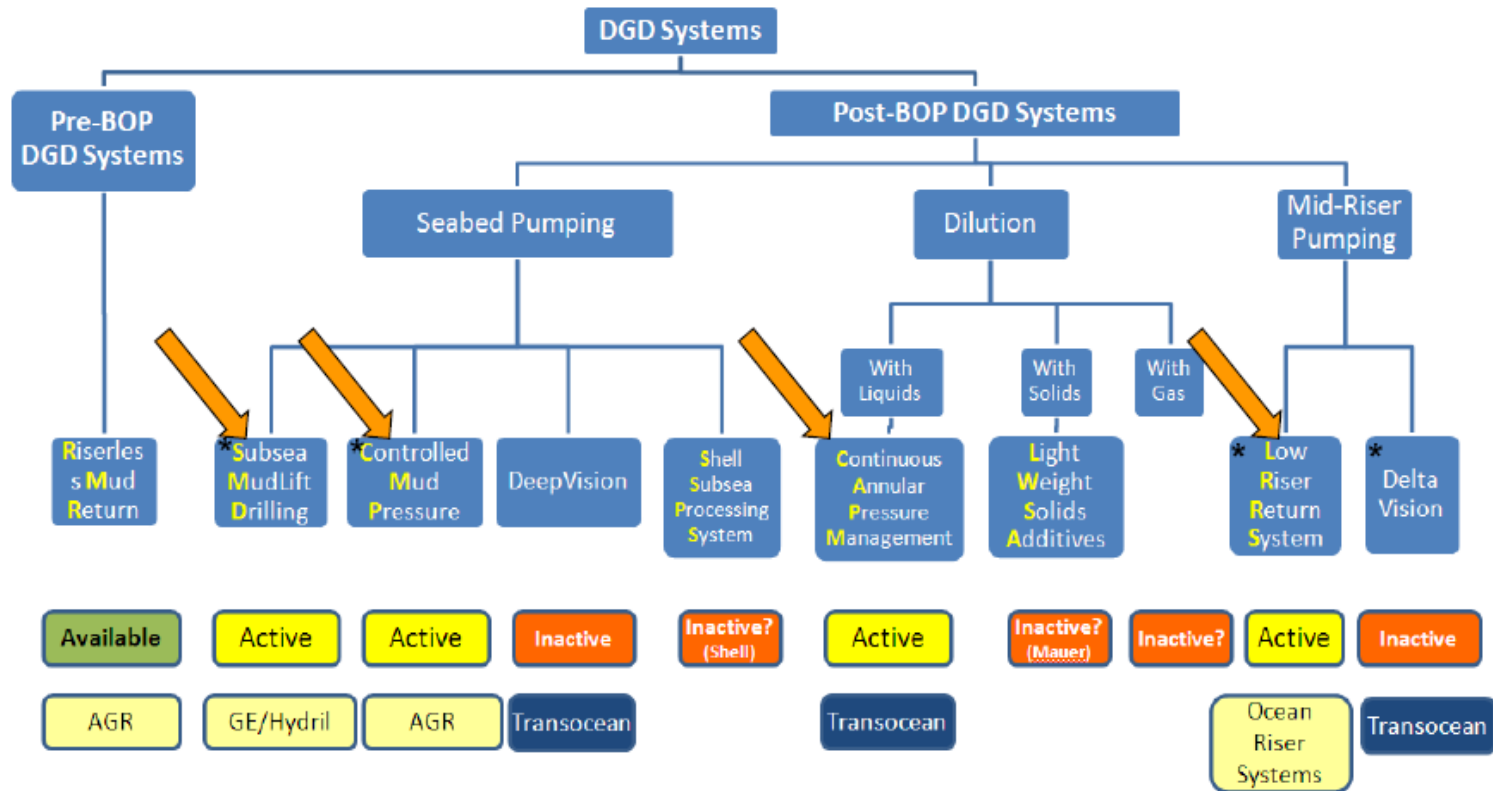
FIG. 1



Configuration of Automated Closed-Loop System Using a RCD



# Dual Gradient Drilling (DGD)



\*Note: These systems can be classified as, "Controlled Riser Fluid Level" systems under the IADC MPD Screening tool under development  
Source: Ken Smith, IADC Dual Gradient Drilling Workshop, May 2011

## Four Different Types of Post-BOP DGD Systems

# IADC MPD Selection Tool



**IADC MPD Selection Tool**

Introduction | **MPD Technology Introductions/Descriptions** | Well Description Input and Output | Data - Basis of Technology Ratings

**Well Location Considerations**

☐ Onshore - Surface BOP Stack

☐ Offshore - Surface BOP Stack

☐ Offshore - SS BOP Stack

☐ Offshore - Water Depth < 500 ft (150 m)

☐ Offshore - Water Depth 500 ft (150m) to 1500 ft (450 m)

☐ Offshore - Water Depth - 1500 ft (450 m) to 5000 ft (1500 m)

**Drilling Fluid Considerations**

☐ Single-Phase - Water-Based

☐ Single-Phase - Oil-Based

☐ Multi-Phase - Water-Based

☐ Multi-Phase - Oil-Based

**Drilling Package and Ancillary Equipment Considerations**

☐ Coiled Tubing Drilling Unit

☐ Floating Drilling Unit - Moored (Semi or Drillship)

☐ Floating Drilling Unit - DP (Semi or Drillship)

**Pressure Profile Considerations**

☐ Pressure Profile prediction uncertainty

☐ Important to determine Pore, Collapse, and Fracture P realtim

**Goals/Objectives**

1 2 3 4 5 List of Goals/Objectives

None

Weighting

1st Goal 10

2nd Goal 5

3rd Goal 3

4th Goal 1

5th Goal 1

Well Control Barrier	Onshore SubSea	Availability Surface Stack Offshore	MPD Technology	Location	Fluid	Pressure Profile Uncertai	Relative Technolo Rating
			a				
			b				
			c				
			d				
			f				
			g				
			h				
			i				
			j				
			k				
			l				
			m				
			n				
			o				
			p				
			q				

Enter Comment Here

IADC MPD Selection Tool – Well Description Input and Output Screen

# Human factor



- Lack of experienced rig personnel on new drill ship
- Experienced personnel are retiring with “old way” knowledge to recognize well control.
- Younger crew have less experience recognizing the kick.
- Kicks often occur and the time between actual occurrence of a kick and someone recognizing the kick could be up to, if not more than 40 minutes. Enhanced training methods and updated well control technologies should help to reduce this time frame and prevent blowouts.

# Human Factor



- Providing good kick detection training to the operations personnel is invaluable.
- Most companies have their own internal customized well control training which their personnel have to take regularly to qualify to work on the well control equipment of that company.
- One of the service companies surveyed sends their personnel to well control training on a test rig where they are told to circulate a gas kick out of the well. This gives the personnel an exact idea on what to expect of their equipment when there is a kick in the wellbore. This hands-on drill solidifies the classroom training received by the personnel.

# Summary



- Kick duration increased from 77 to 160 BOP days for deepwater GoM exploration wells for 1997-1998 and the period 2007-2009. This equates to a 50% reduction in kick frequency.
- Exploration drilling has more frequent kicks than development drilling as exploration drilling is done in less known formations.
- Kick detection technologies like MWD, Wire drill strings, can be used to early influx or losses and sound the alarms to notify the personnel on the rig.
- Managed Pressure Drilling (MPD) has been used and perfected for many years for shore based drilling and is now being utilized in offshore drilling.

# Summary



- Dual Gradient Drilling (DGD), a form of MPD, uses a subsea Mud Lift Pump (MLP) located above the BOP and will be implemented by Chevron in the GoM.
- IADC's MPD Selection Tool helps to familiarize users with MPD techniques, MPD's relative capabilities and the type of technologies available depending on the user's objectives.
- Most companies have their own internal customized well control training which their personnel have to take regularly to qualify to work on the well control equipment of that company.

# Reference



- Final Report 03 –Kick Detection and Associated Technologies



# Questions

